May 21, 2015 NRA International Symposium

Report from NRA: New Regulation Standards against Natural Hazards

NRAからの報告：新規制基準における自然現象への対応

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Nuclear Regulation Authority

Japan

石渡　明（原子力規制委員会委員）

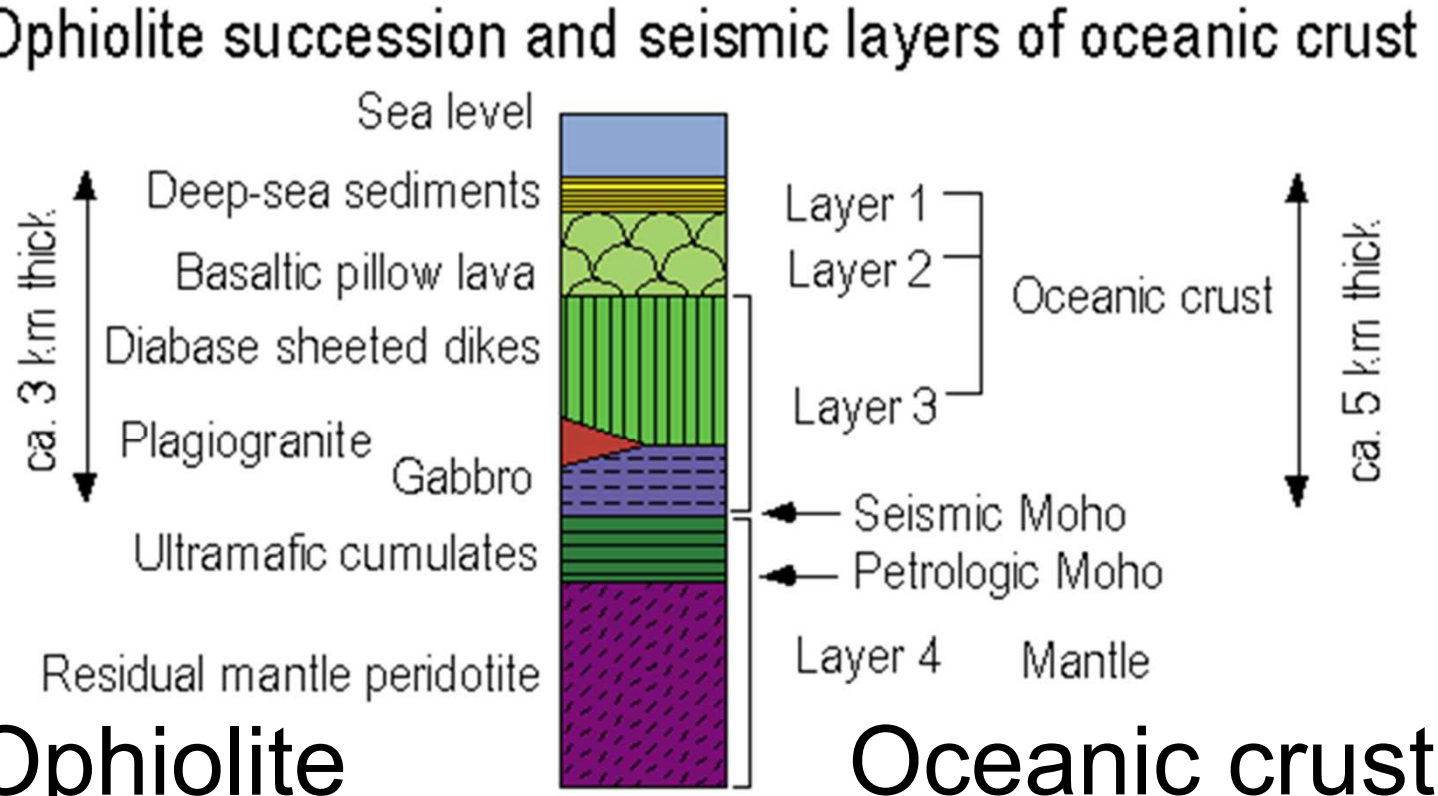
Topics

A. Research Background of Ishiwatari

1. Geology and Petrology of Ophiolites
2. Active Faults, Earthquakes and Tsunamis
   (Mar. 11, 2011 experience)

B. NRA's New Regulation Standards against Natural Hazards (Active Faults, Earthquakes, Tsunamis and Volcanos)

Research Background 1. Geology and Petrology of Ophiolites



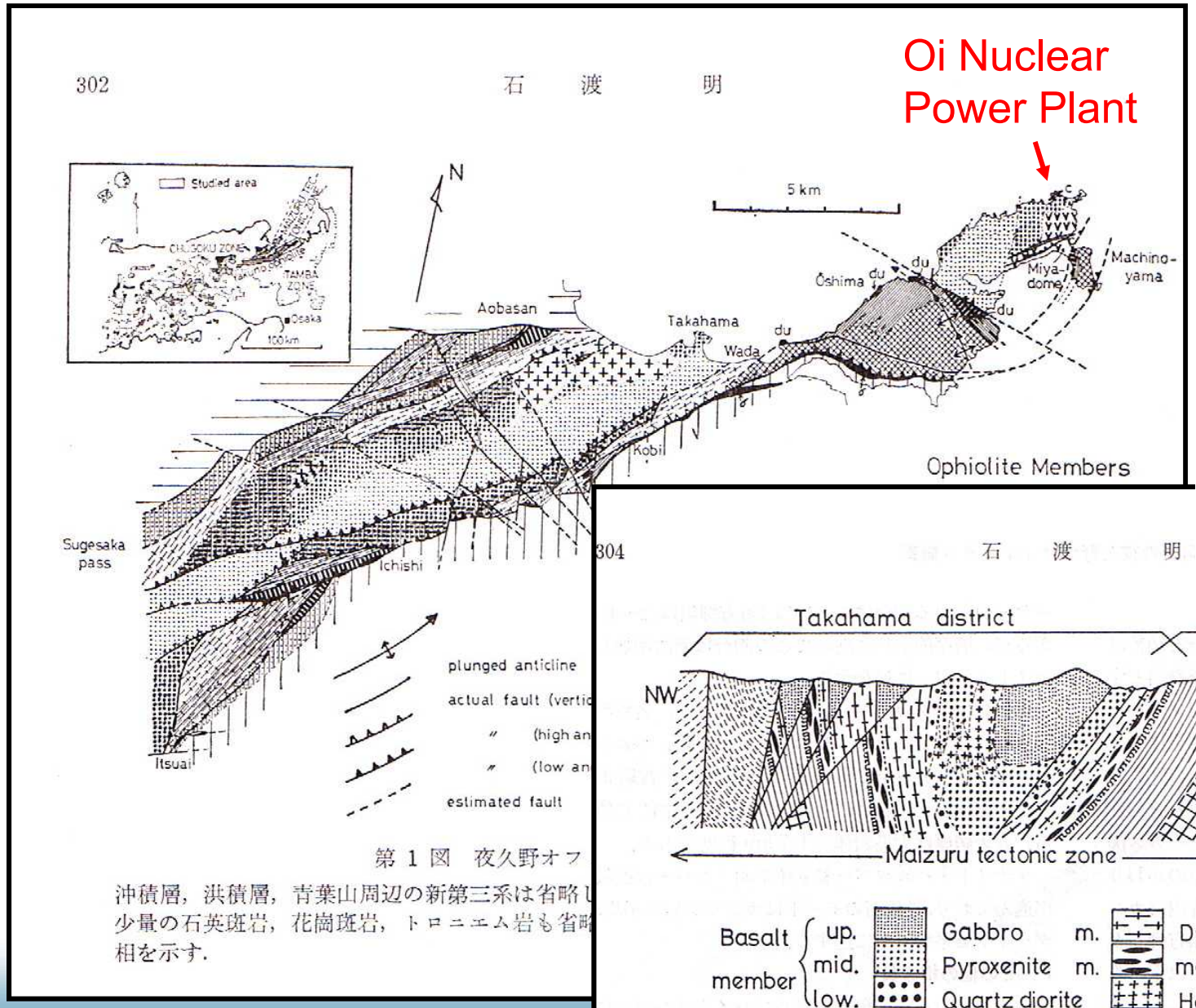
Ophiolite (on land)

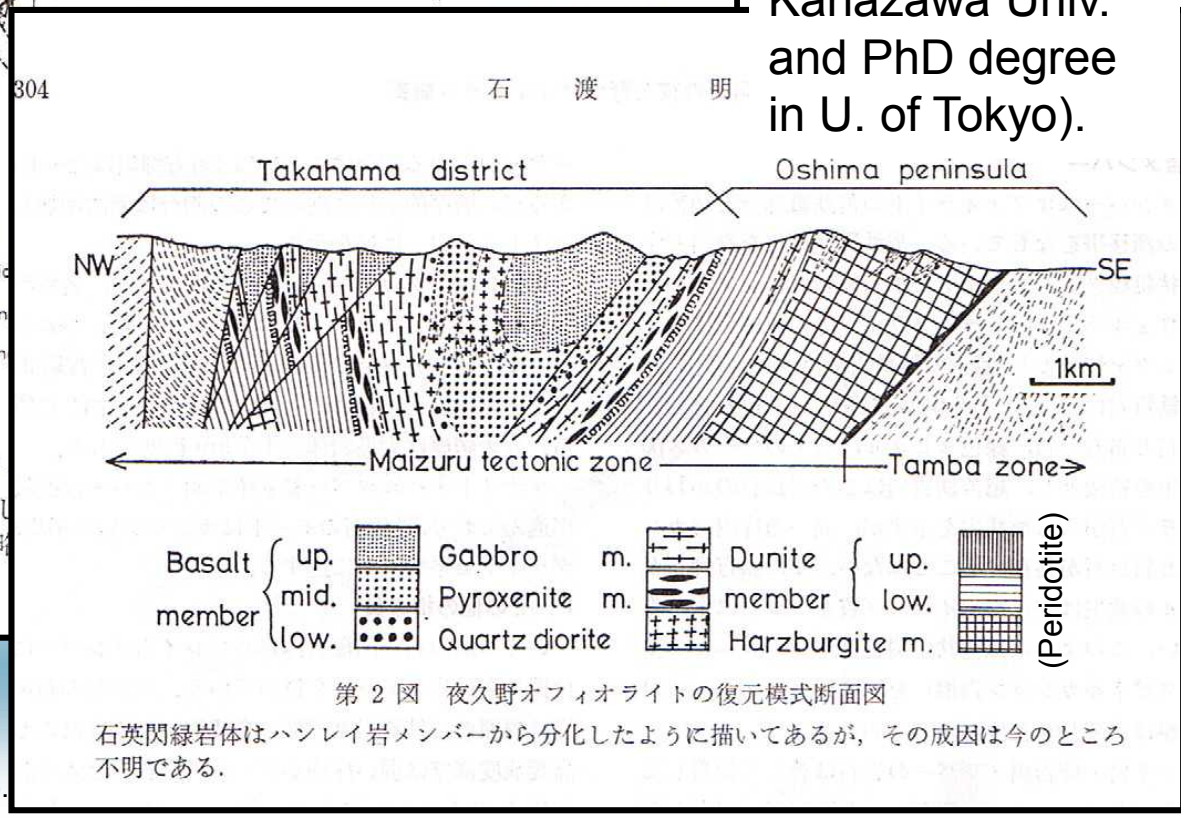
Oceanic crust (sea floor)

http://earth.s.kanazawa-u.ac.jp/ishiwata/ophiol_e.htm

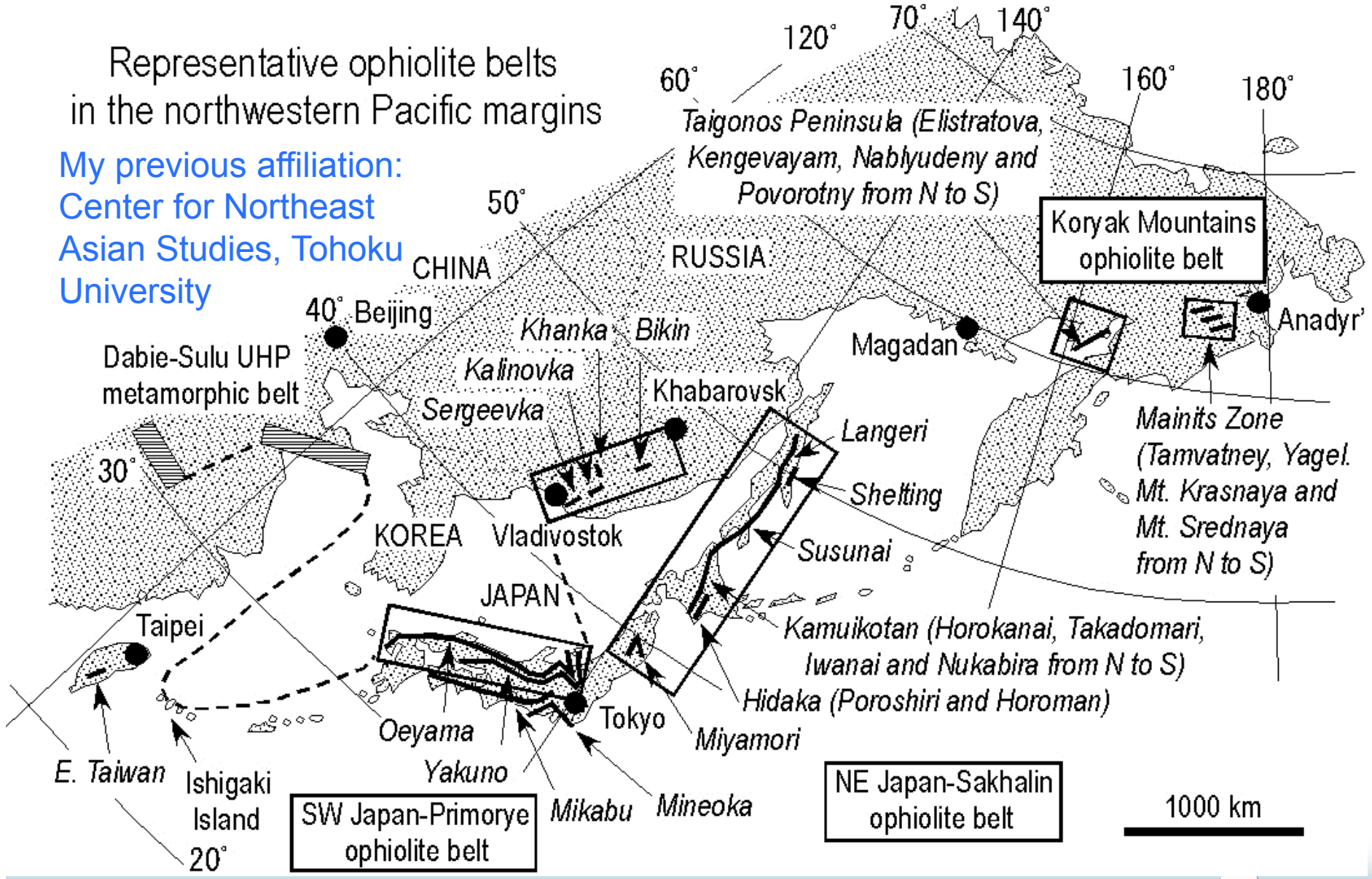
First in Japan

My 1978 paper on the Yakuno ophiolite was the first report of a full ophiolite in Japan (Master degree in Kanazawa Univ. and PhD degree in U. of Tokyo).

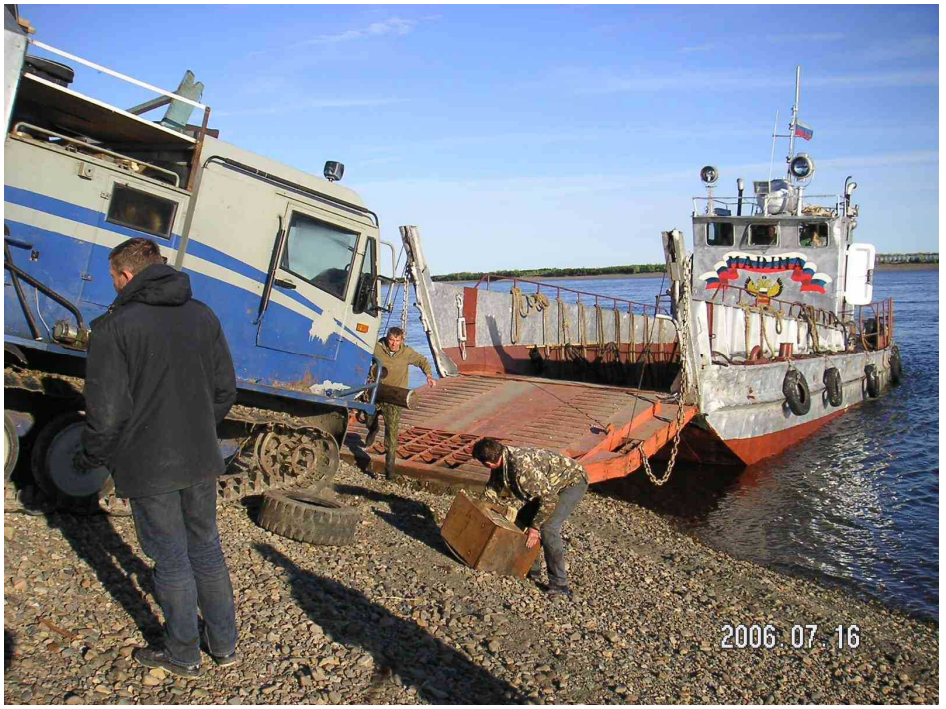




Ishiwatari, A. (1978) A preliminary report on the Yakuno ophiolite in the Maizuru zone, Inner Southwest Japan. Chikyu Kagaku (Earth Science), 32(6), 301-310 (in Jpn.).



Ishiwatari, A., Sokolov, S.D. & Vysotskiy, S.V. 2003: Petrological diversity and origin of ophiolites in Japan and Far East Russia with emphasis on depleted harzburgite. *Geological Society of London, Special Publication.*, **218**, 597-617.

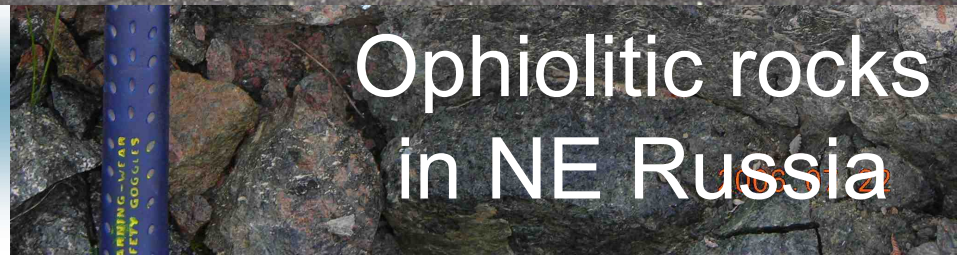


Joint ophiolite studies in NE Russia

Upper left: City of Anadyr, Chukotka

Upper right: Our car and boat

Lower left: Our camp



Ophiolitic rocks in NE Russia

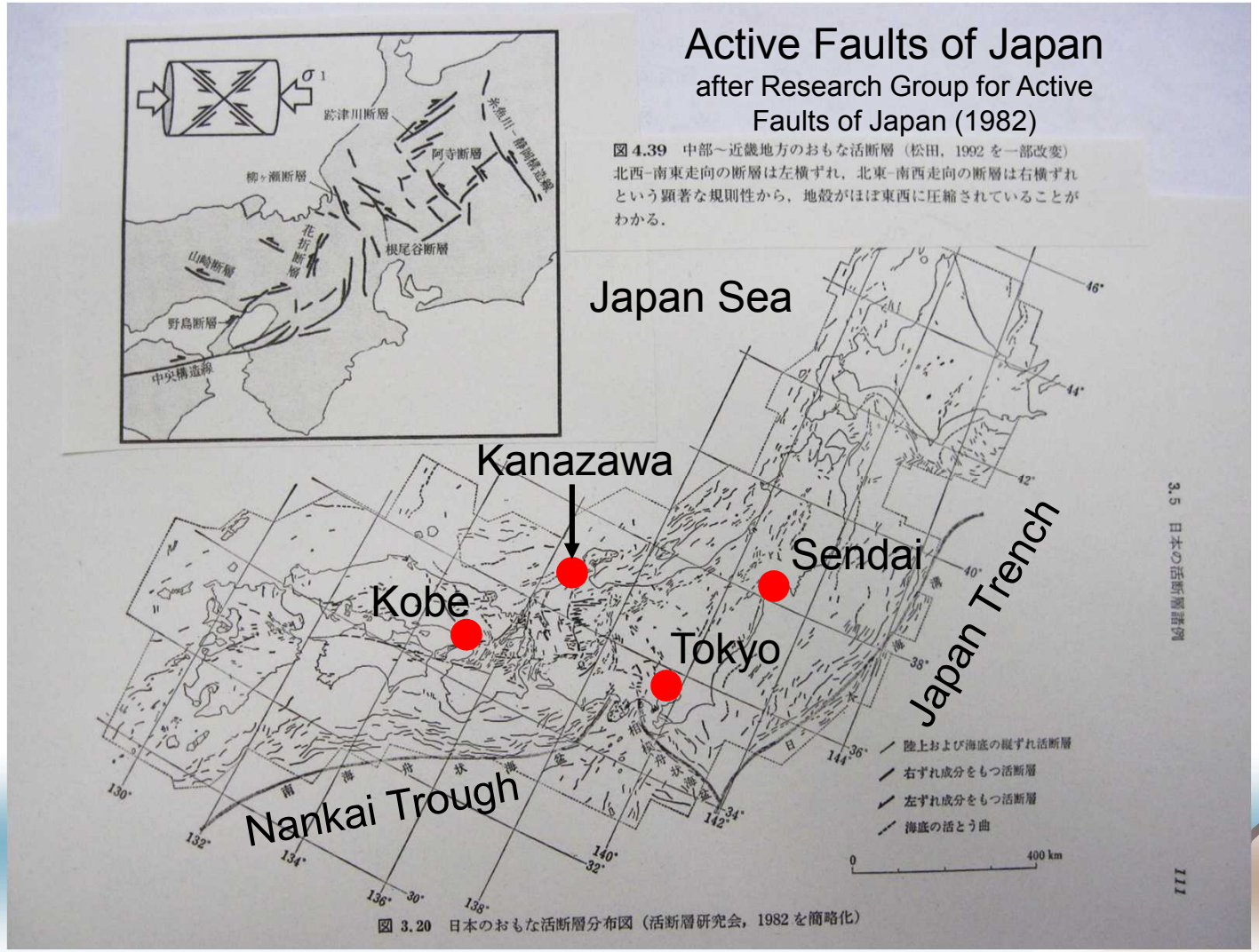
Research Background 2. Active Faults, Earthquakes and Tsunamis

References:

Kato, H. 1989: Science of Earthquake and Active Faults. Asakura Shoten.

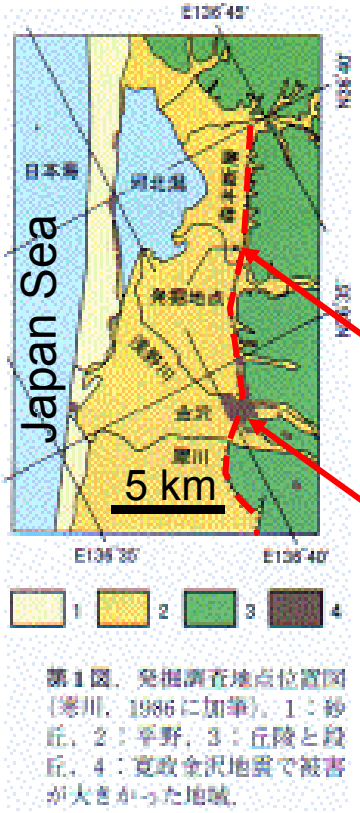
Inset: Nishimura, Y. et al. 2010: Basic Earth Science (2nd Ed.). Asakura Shoten.

(both in Japanese)



After the disastrous 1995 Kobe earthquake, active fault researches have been in bloom all over Japan.

Morimoto Active Fault in Kanazawa City, Central Japan



第1図．発掘調査地点位置図（寒川，1986に加筆）．1：砂丘，2：平野，3：丘陵と段丘，4：震災金沢地震で被害が大きかった地域．

Trench ex-cavation site

Kanazawa City

Active Fault

Latest movement: about 2000 years ago

Ishikawa Prefecture Morimoto Fault Research Group and Ishikawa Prefecture Environment and Safety Affairs Department 1997: Excavation of the Morimoto active fault in Kanazawa City, central Japan. Journal of the Geological Society of Japan, 103(10), XXXI-XXXII. (in Japanese)

http://earth.s.kanazawa-u.ac.jp/ishiwata/labo/morimoto.html

Mar. 11, 2011 Tohoku-oki Earthquake

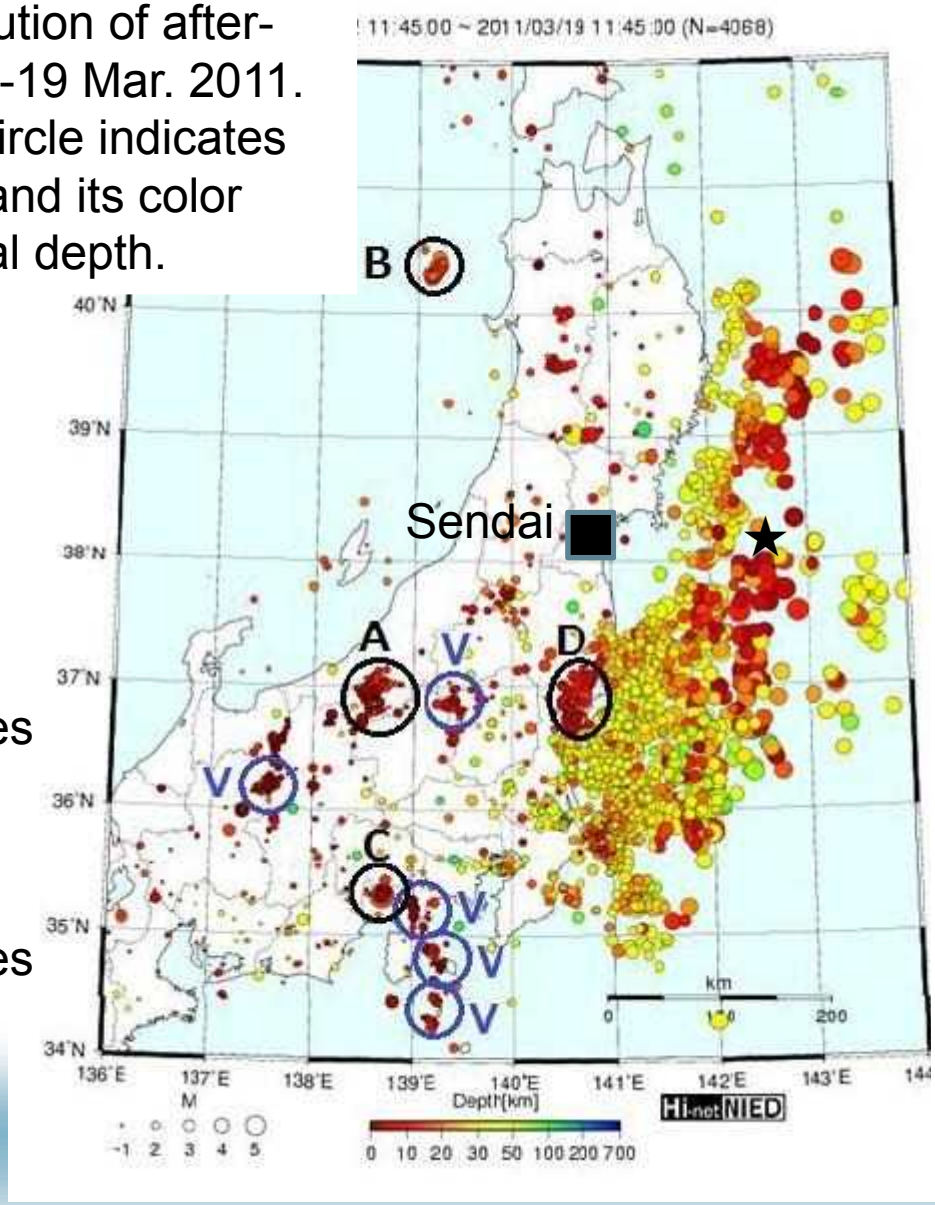
Mar. 11 to May 7, 2011

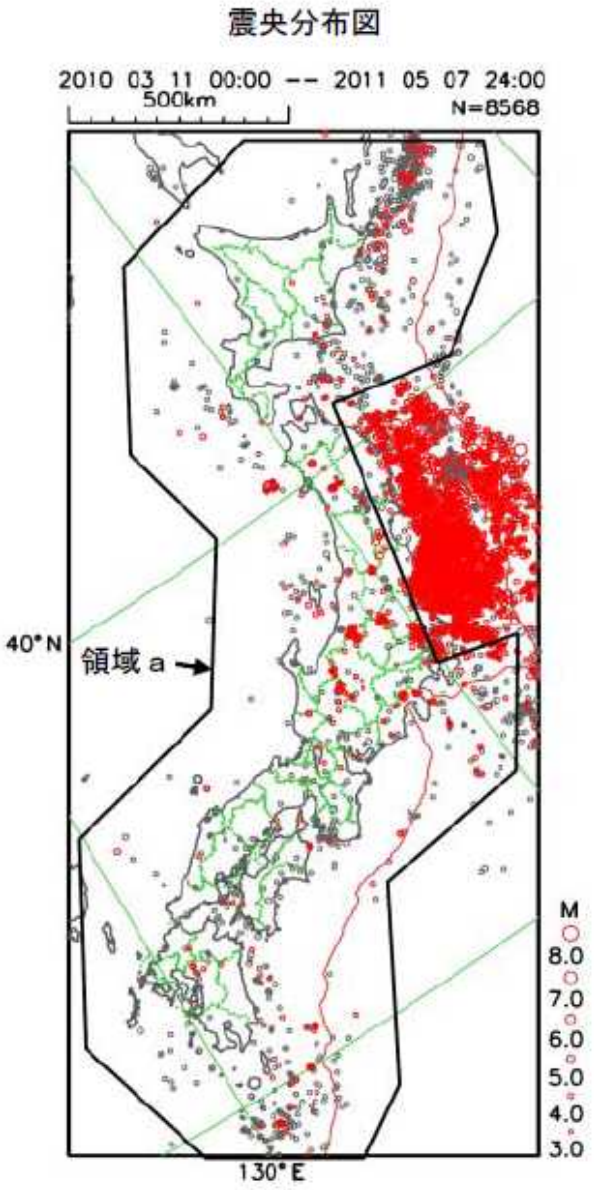
Focal distribution of after-shocks in 12-19 Mar. 2011. Size of the circle indicates magnitude, and its color signifies focal depth.

★ Main shock (M9.0)

A, B, C, D: “Induced “ earthquakes

V: Volcanic earthquakes

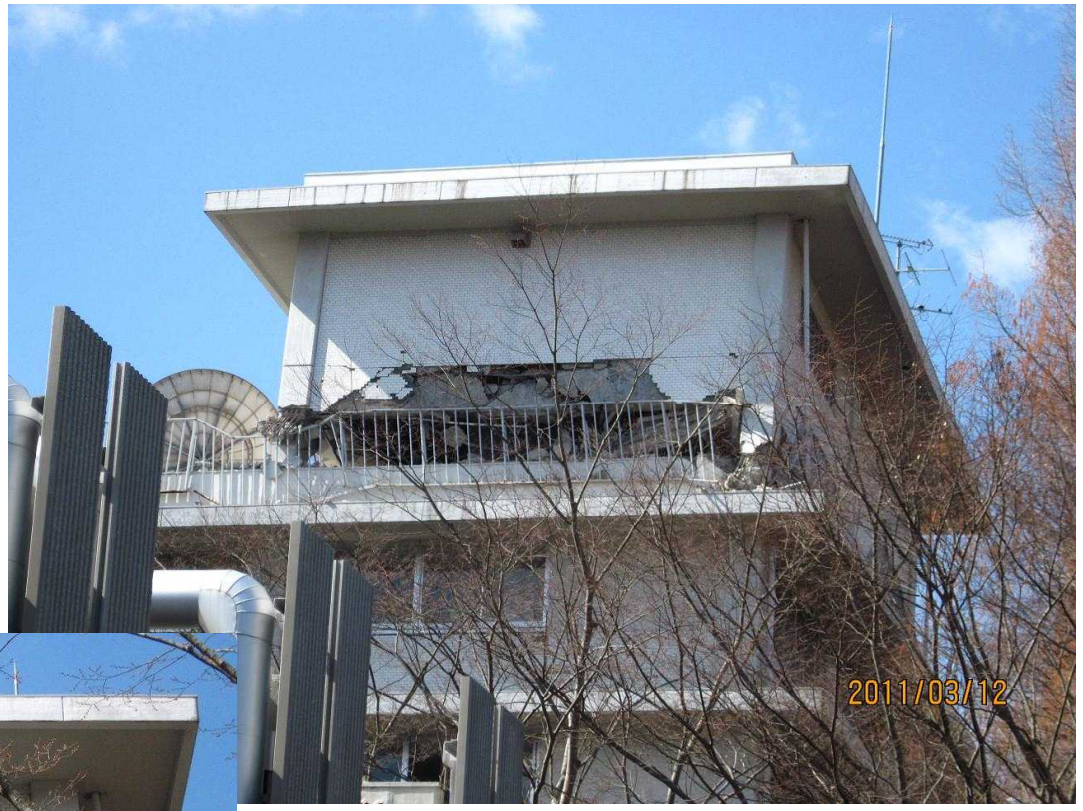




Japan Meteorological Agency:1104tohokuoki.pdf

Seismic Damages in Sendai (Tohoku)

After Mar. 11 Main Shock (photographed on Mar. 12)



Center for NE Asian Studies, Tohoku Univ.

After Apr. 7 Aftershock (photographed on Apr. 12)

http://www.geosociety.jp/hazard/content0055.html

Tsunami Damages In Sendai (Tohoku)

Tsunami-inundated rice paddies in Miyagino-ku, Sendai City

Study of tombstone fall-down rate in cemeteries around Sendai (Tohoku)

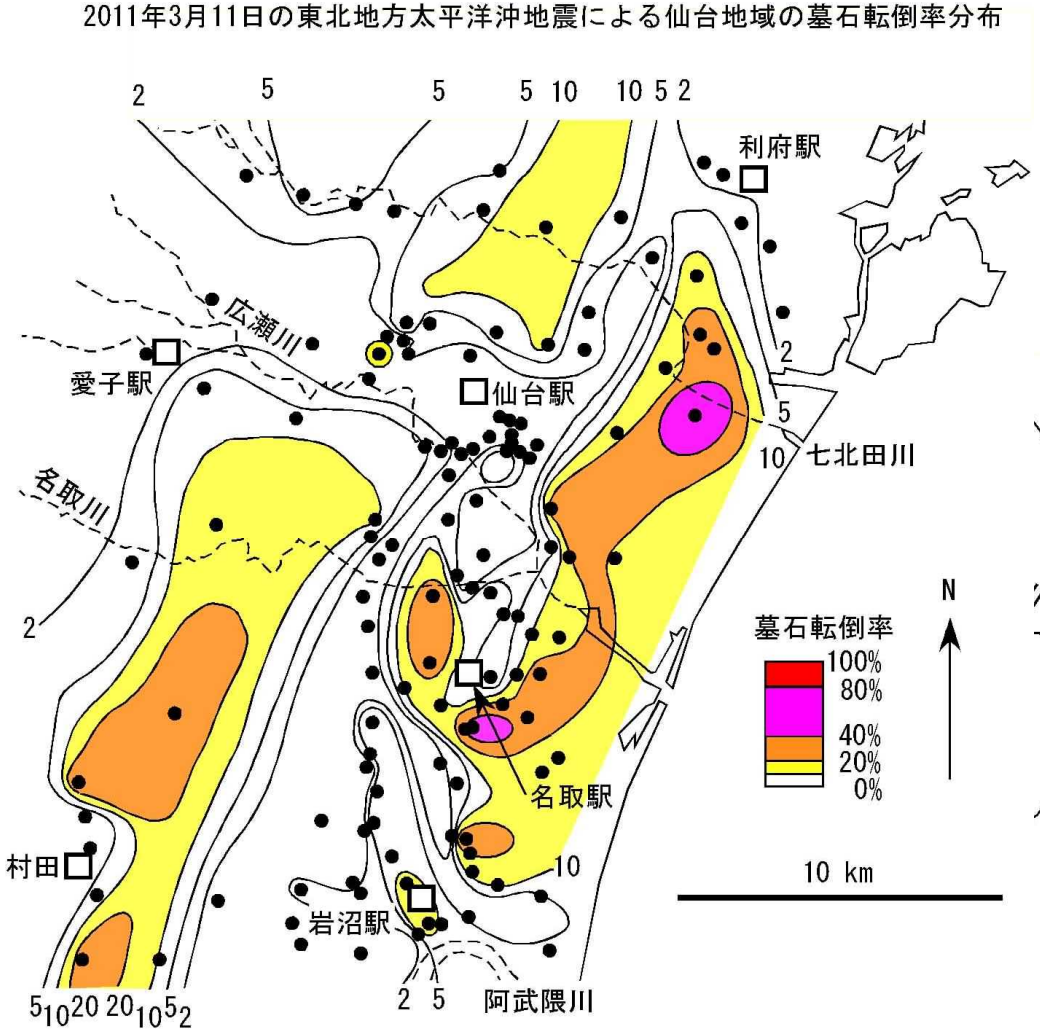
Japanese tombstones: hardly survived (front) and fallen down (back right)

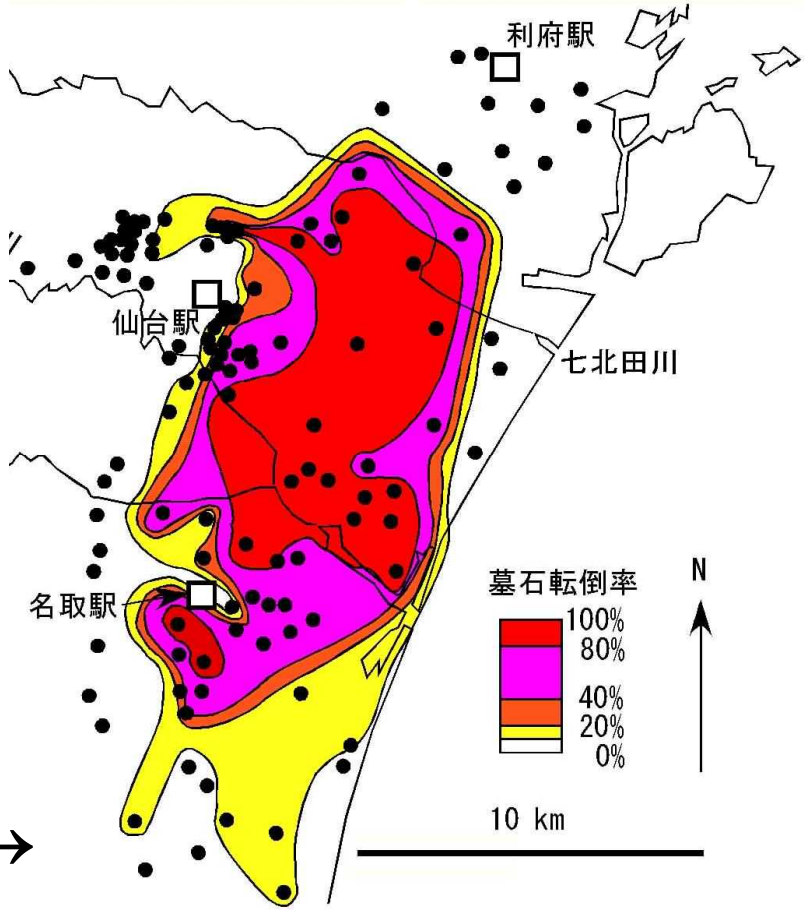
Japanese cemetery damaged by tsunami in Miyagino-ku, Sendai

http://www.geosociety.jp/hazard/content0055.html

Tombstone Fall Down Rate in Sendai (Tohoku)

←2011 (M9.0)





1978 (M7.4)→

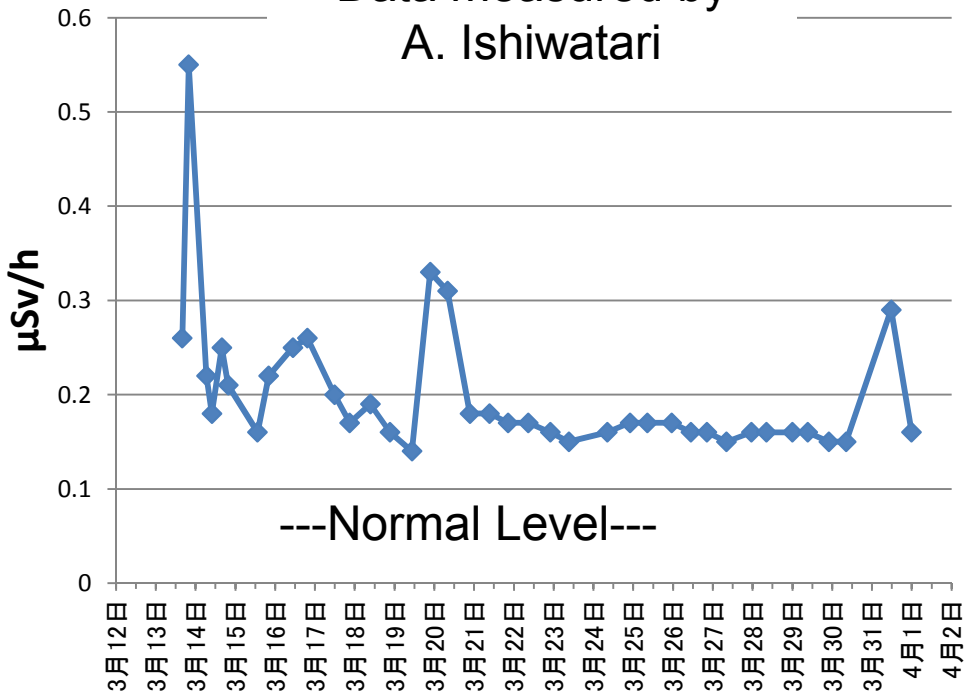
http://www.geosociety.jp/hazard/content0055.html

東北大学理学部地質学古生物学教室(1979)「1978年宮城県沖地震に伴う地盤現象と災害について」，東北大学理学部地質学古生物学教室研究邦文報告，80，1-97のデータに基づいて石渡が作図

Fukushima Daiichi Nuclear Power Plant Accident on Mar. 11, 2011

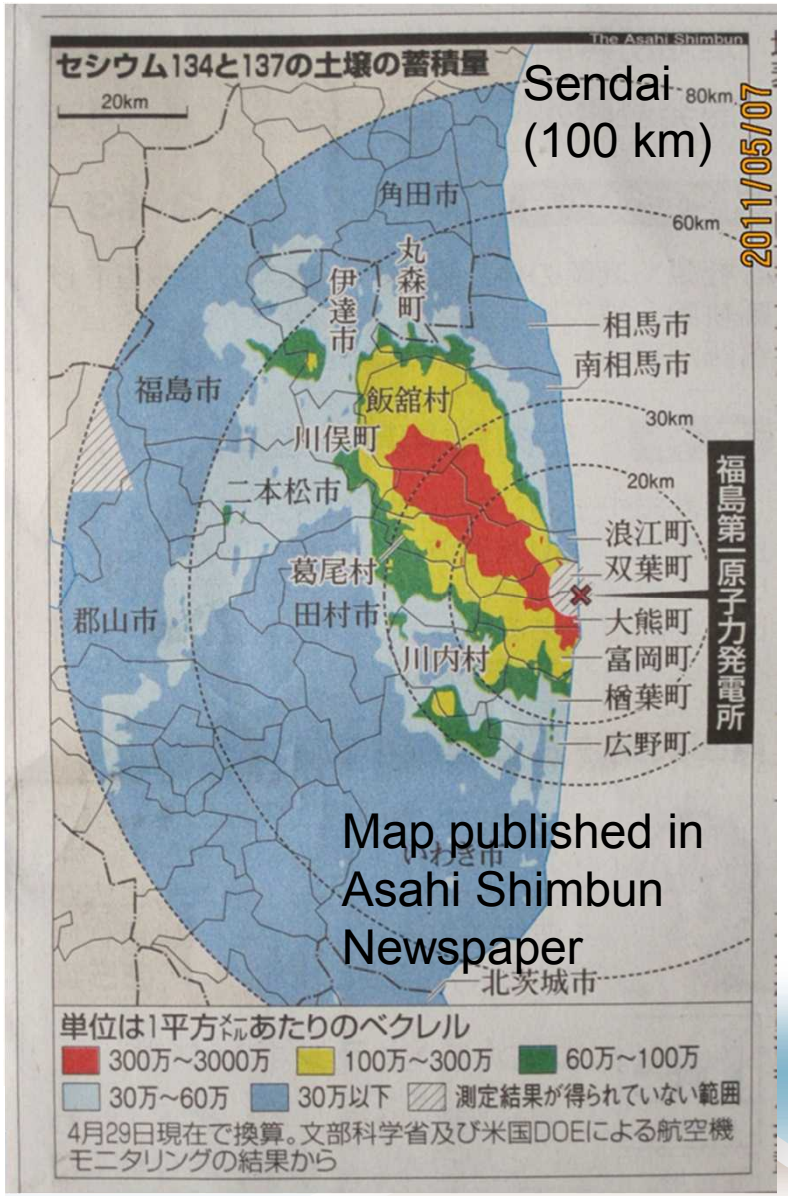
Radioactivity in Sendai (Tohoku)

Data measured by
A. Ishiwatari



http://www.cneas.tohoku.ac.jp/labs/geo/ishiwata/RadiationSendai.htm

Distribution of Cs-134 and Cs-137 in the ground around Fukushima Daiichi

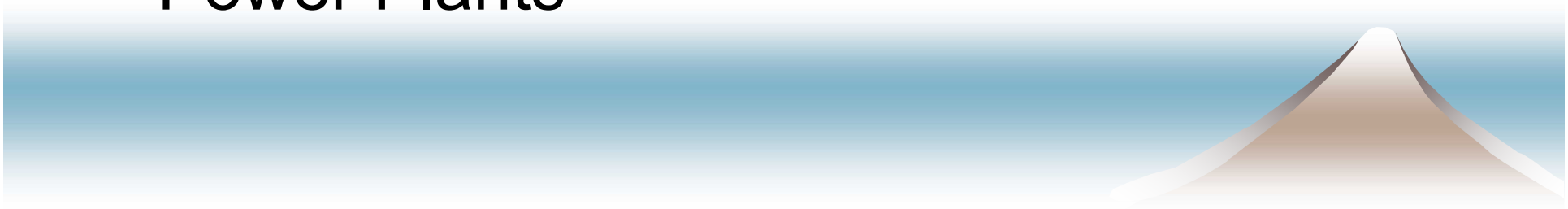


Background Summary

- I have long made international geological studies of ophiolites and ocean floor. I also studied active faults and seismic damages.
- I chaired peer-review meetings of NRA to evaluate activity of faults in nuclear sites as the president of the Geological Society of Japan. I think this lead me to the present job.
- In NRA, I am responsible for nuclear regulation matters related to active faults, earthquakes, tsunamis and volcanos.

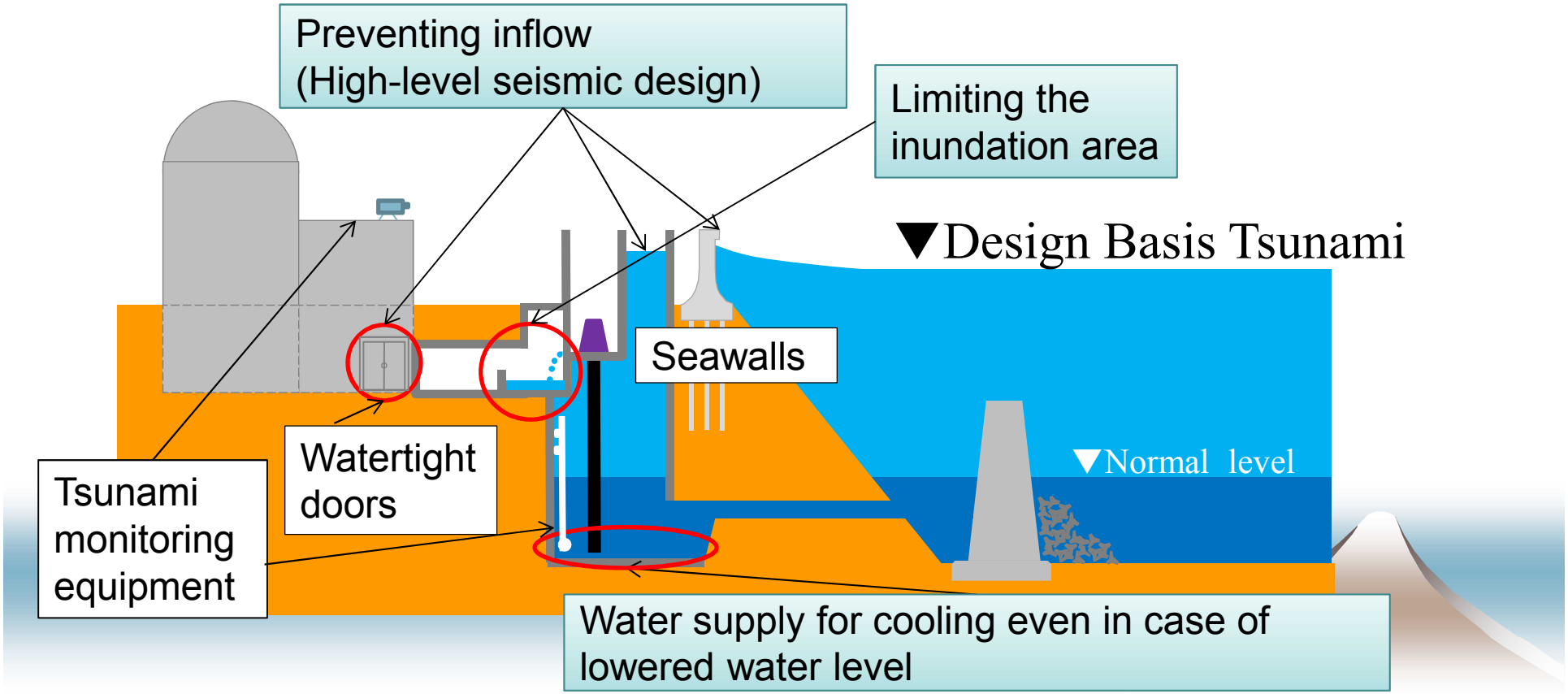
NRA's New Regulation Standards against Natural Hazards

- More stringent standards on tsunami
- Clarification of requirements for fault displacement
- More precise methods to define Design Basis Seismic Ground Motion
- An example: Sendai (Kyushu) Nuclear Power Plants



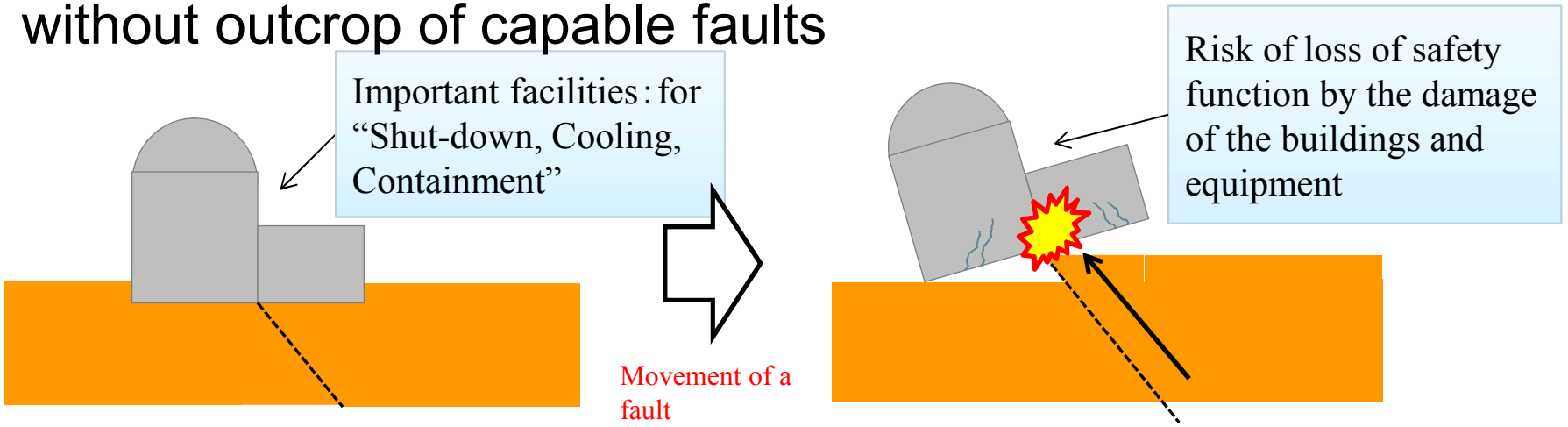
More stringent Standards on Tsunami

- Define “Design Basis Tsunami” that exceeds the largest in the historical records
- Requirements for multiple protective measures



Clarification of requirements for fault displacement

- "Capable faults" need to be determined as those whose activities since the late Pleistocene (approx.120,000 to 130,000 years ago or later) cannot be denied
- Important facilities have to be constructed on the ground without outcrop of capable faults



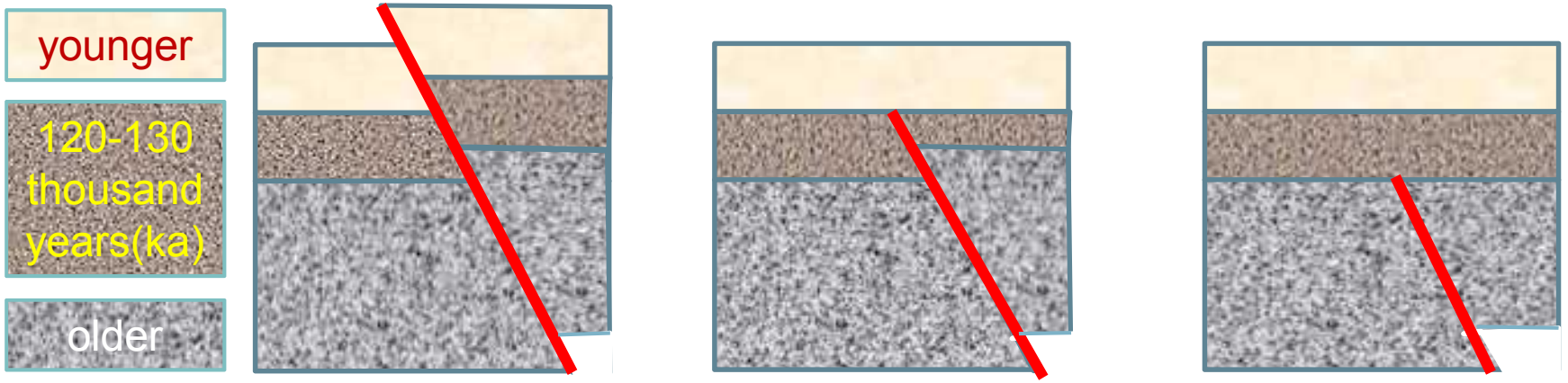
○Movement of the fault under important facilities like Reactor Building may result in the concentration of deadweight onto the spot and cause damage of the building.
○Even in case damage of the building is avoided, safety function can be lost due to the deformation of the facilities or damages of the internal equipment.

How to find an active fault?

In NRA, “capable fault” is the official English term for “active fault”, which is more commonly used in public.
120-130 ka means the base of Late Pleistocene.

1. Covering Bed Method

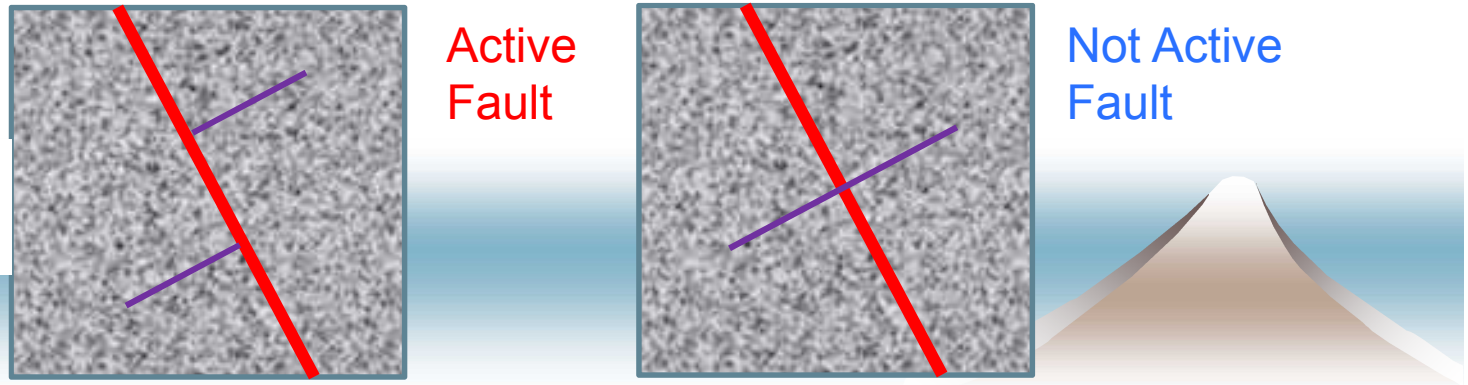
Geological age of bed



Judge: Active Fault | Active Fault | Not Active Fault

2. Crossing Vein Method

— younger dike or vein

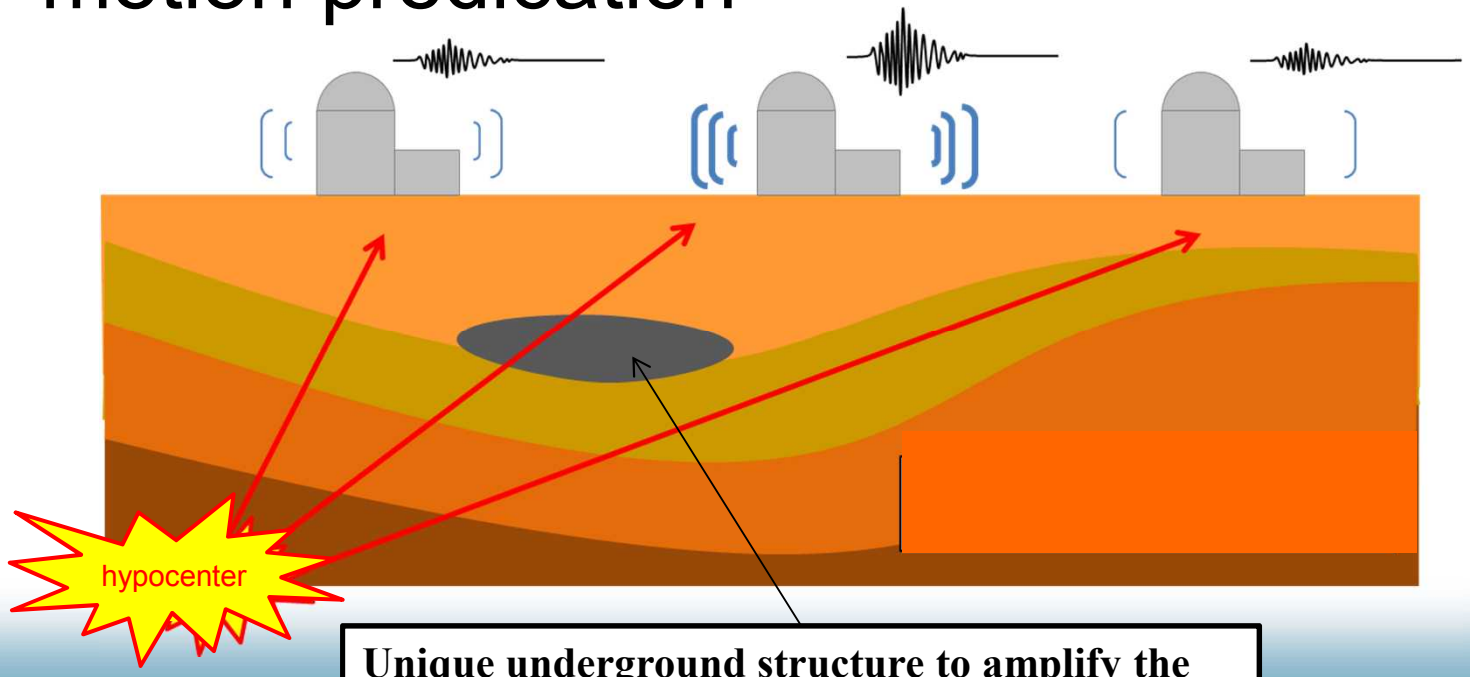


Active Fault

Not Active Fault

More precise methods to define Design Basis Seismic Ground Motion

- Survey 3D geological structure of the site
- Take into consideration of seismic ground motion predication



Reassessment of Sendai NPPs

- Owned by Kyushu EPC
- 2 PWRs, 890,000kW each
- About 30 years operation
- Front onto East China Sea (not directly confront onto plate boundary)

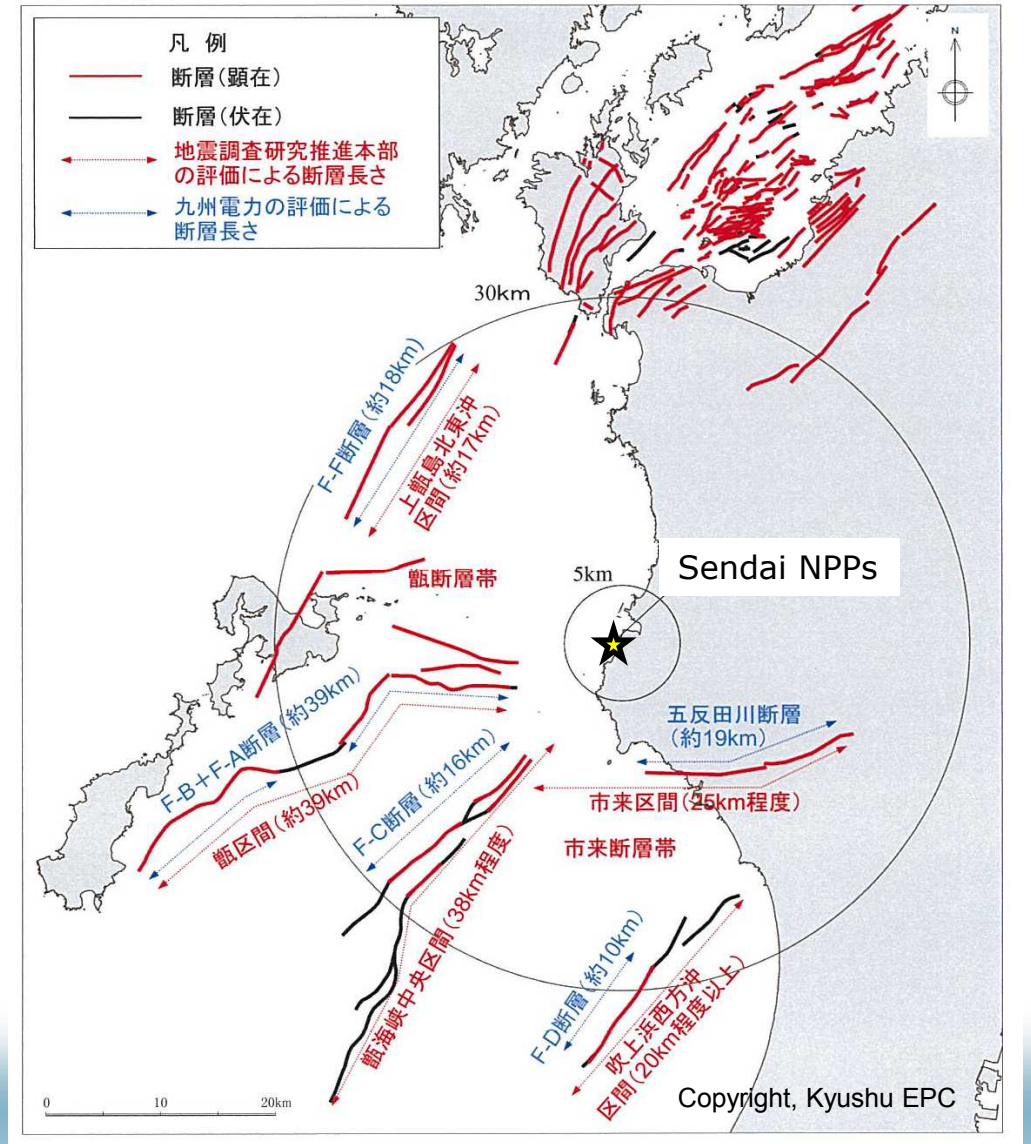
Sequence of reassessment

Jul. 8, 2013
Back-fit safety assessment completed

Jul. 16, 2013
Examination by NRA commissioners and secretariats started
>60 times open-to-public meetings
~700 times closed meetings
Revision after public comments

Sep. 10, 2014
Permission for basic design decided
(Examination for details is in progress; e.g. assessment for seismic safety of each facility)

The length of capable faults



Capable faults around Sendai NPPs

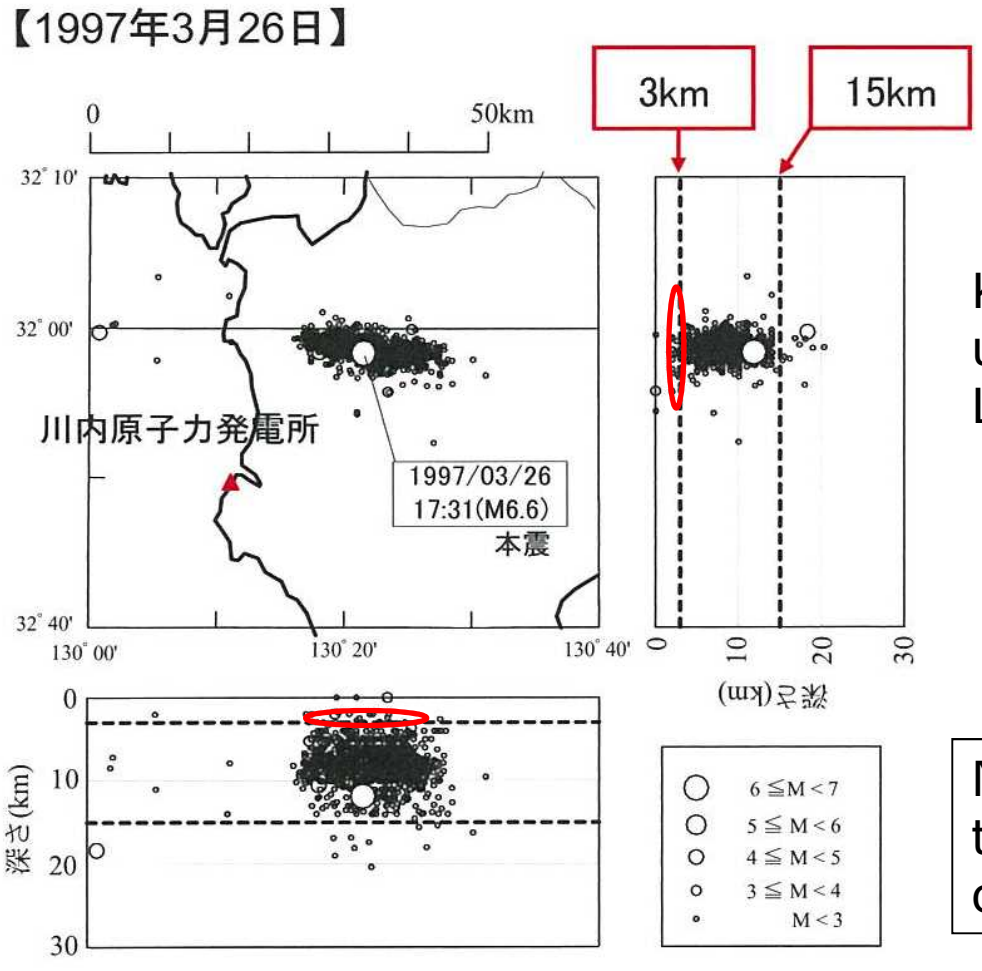
MORE LENGTH!

Blue: Fault length assessed by Kyushu EPC

Red: Fault length assessed by The Headquarters for Earthquake Research Promotion (HERP)

NRA required to extend the length of faults at least the length assessed by HERP

Seismogenic fault model



Copyright, Kyushu EPC

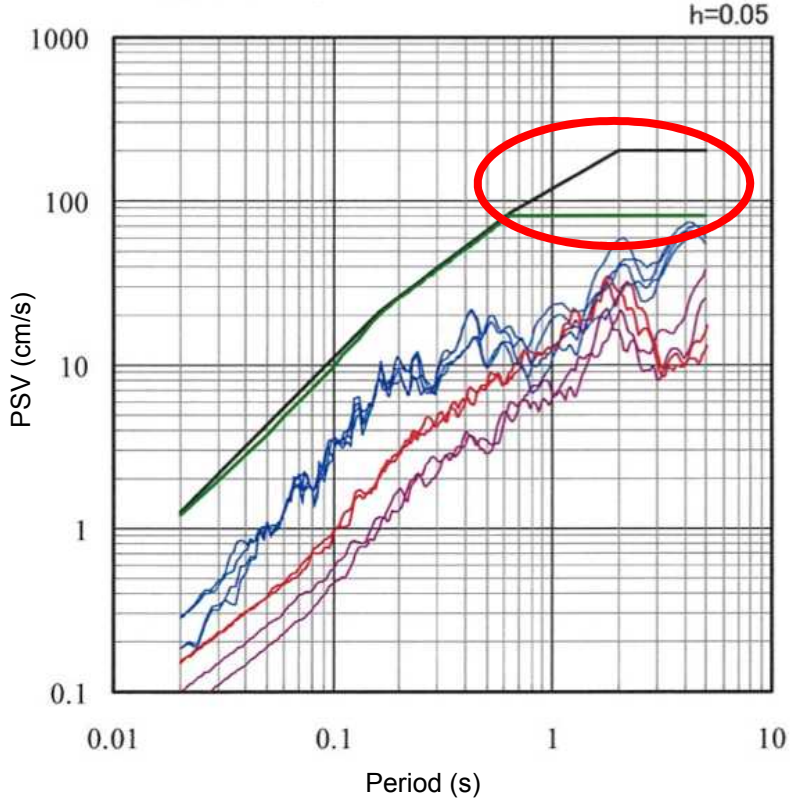
Distribution map of aftershocks,
Kagoshima Northwest Earthquake 1997

MORE DEPTH RANGE!

Kyushu EPC estimated the upper limit of Seismogenic Layer as 3km depth

NRA required to re-estimate the limit as 2km depth based on the distribution data

Design basis ground motion for seismically isolated building



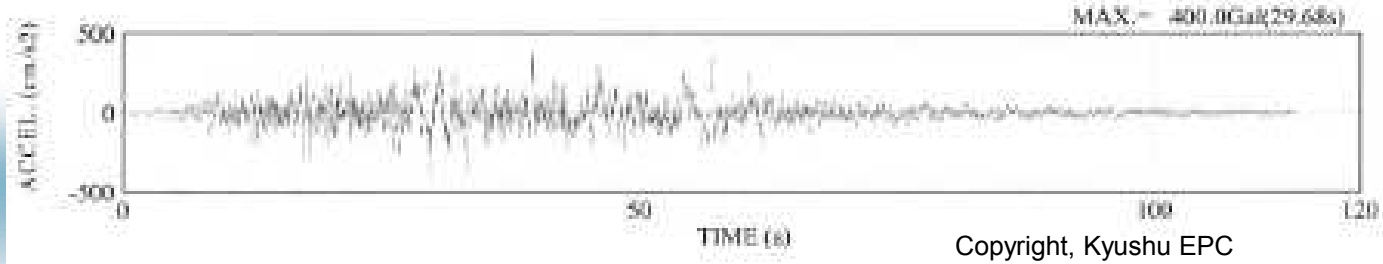
STRONGER SHAKE!

Ss-L

Ground Motion Spectra by long faults around Sendai NPPs

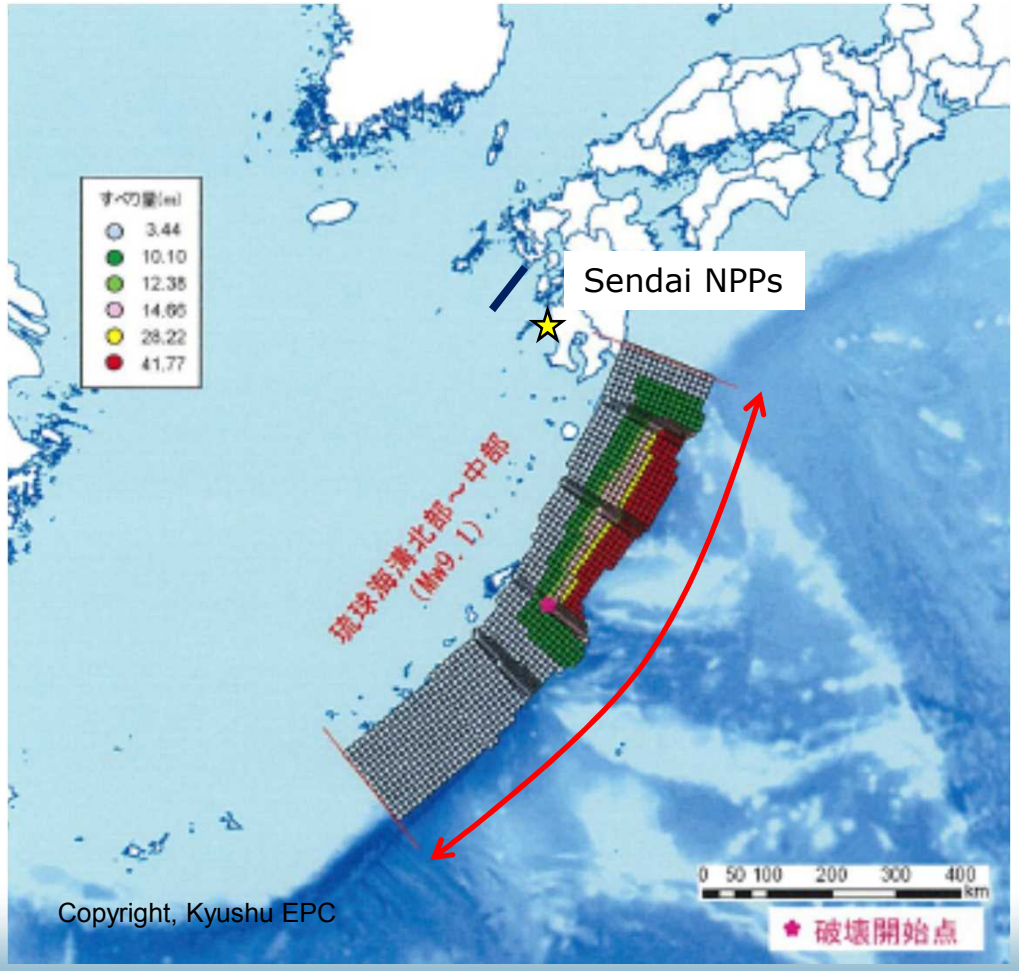
Ref. : Spectrum for super-tall building design

NRA required to add the Design Basis Ground Motion for seismically isolated building (Ss-L) , which is strengthened for the long-period waves



Tsunami sources

MORE WAVE HEIGHT!



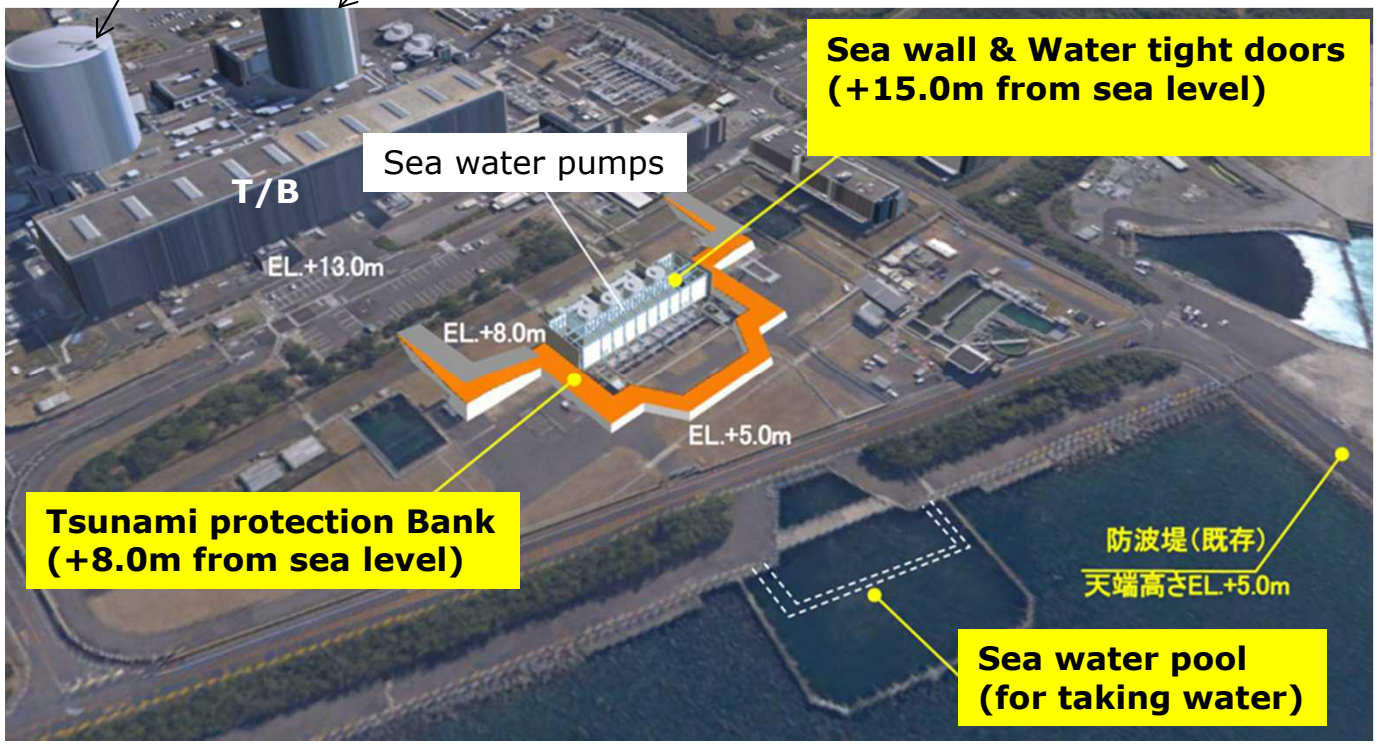
Nagasaki spur fault
(length:86km, Mw7.6)

Northern and central part of Ryukyu trench
(length:approx.900km, Mw9.1)

NRA required to estimate the tsunami height caused by northern and central part of Ryukyu trench*

* Any tsunami caused by this wide area have never recorded, but the possibility to break several segment simultaneously, as the Great East Japan Earthquake, should be considered.

Tsunami protection



Demands of NRA

Amendments: Design Basis Ground Motion

At construction: 372 gal (gal=cm/s^2)

↓

At application: 540 gal

↓

After reassessment: 620 gal

Design Basis Tsunami

At construction: Not considered

↓

At application : +2.07m (upper), -1.96m(lower)

↓

After reassessment : +3.52m(up.),- 3.80(low.)

Conclusion (Principal aims of NRA)

- Protect human life & environment – our goal
- Independent scientific & technical decisions
- Field-based, effective regulation
- Open & informed regulation processes
- Professional moral & ability by daily studies
- Immediate & organized action at crisis